Idaho National Engineering and Environmental Laboratory

The Need for Nuclear Power

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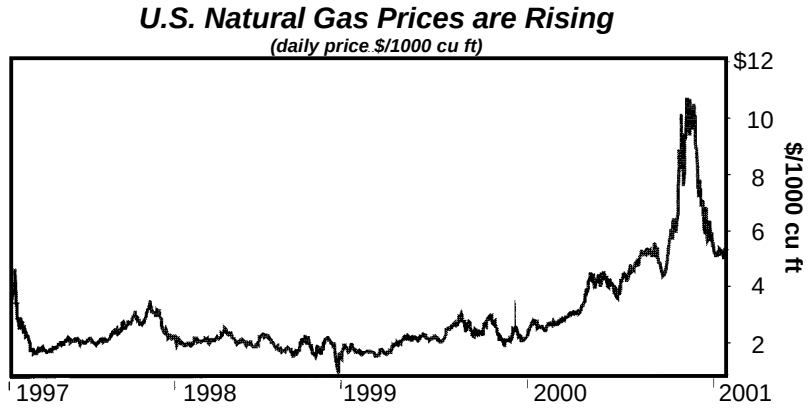
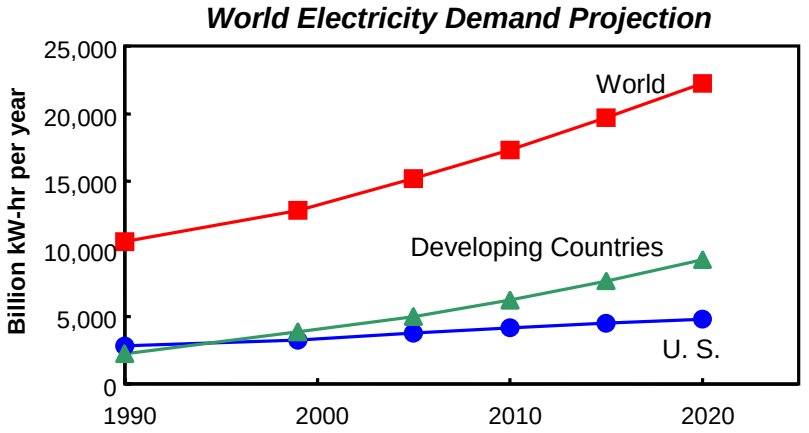
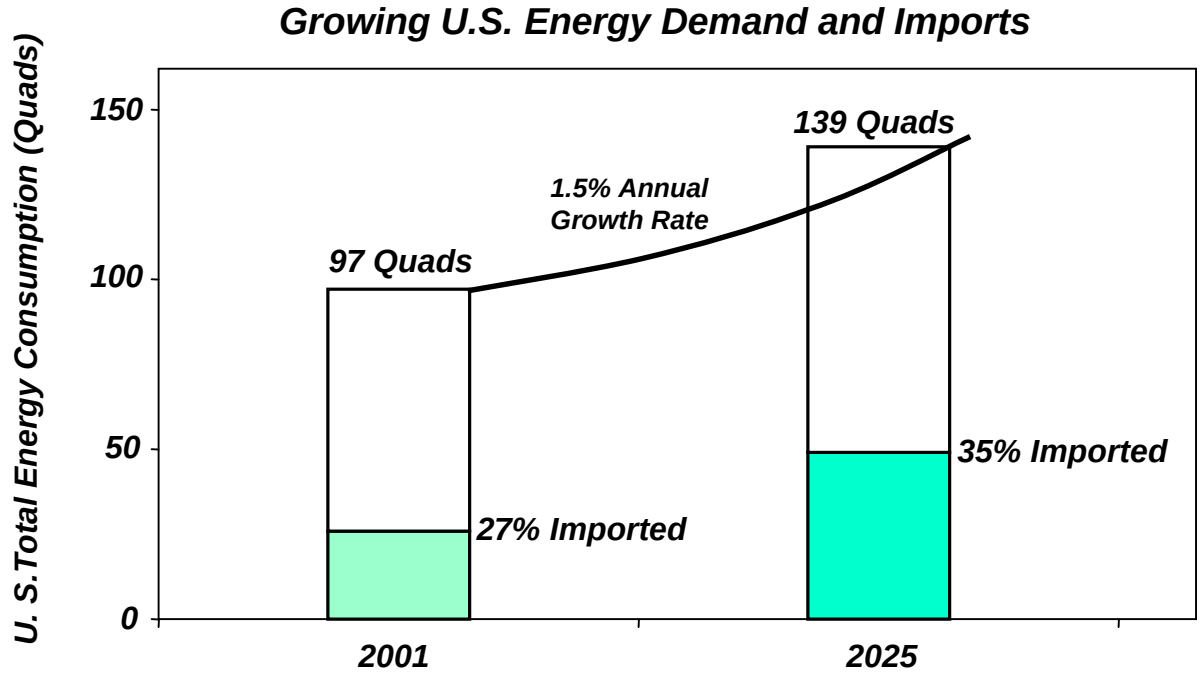
Energy - On Everyone's Mind

- *Regional energy shortages*
- *Increasing natural gas and oil prices*
- *World electricity demand is rising 2.7%/year*
- *2330 GW of new world electrical generating capacity needed by 2020*
  - *324 GW in the U.S.*
  - *69 GW replacement in the U.S.*
- *Energy is a critical component of sustained economic growth and improved standard of living*
- *We desire abundant, affordable, clean energy for world prosperity*





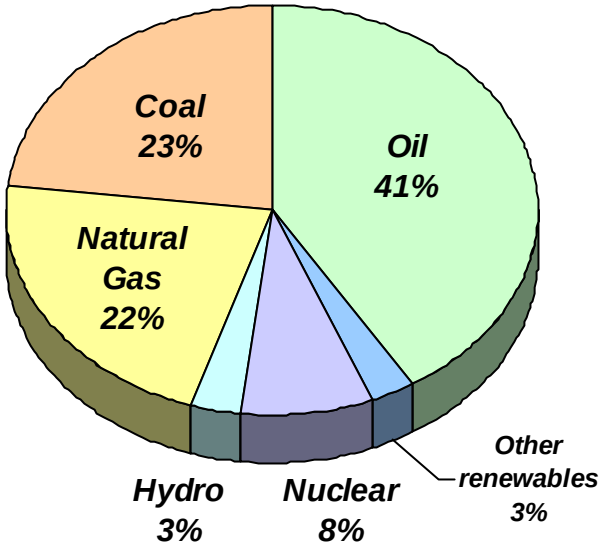
Forecast for U.S. Energy Growth



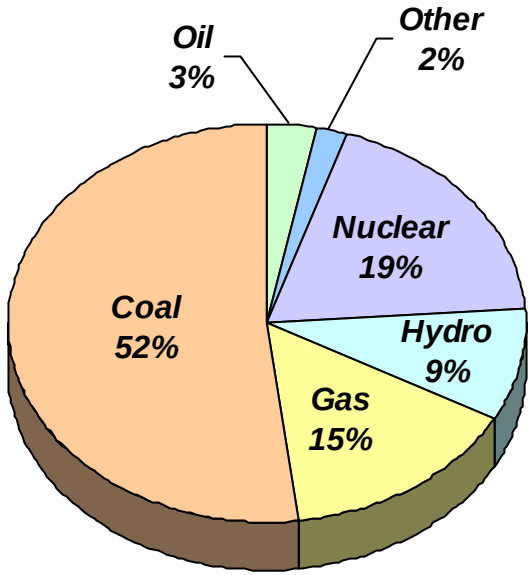
Source: 2003 Annual Energy Outlook

- Annual outlook is 1.5% growth in U.S. energy to 2025
- Most growth is in natural gas and coal
- Imports will increase
- Nuclear can contribute if deployed in the near term

Why Nuclear Energy?… we depend on it today



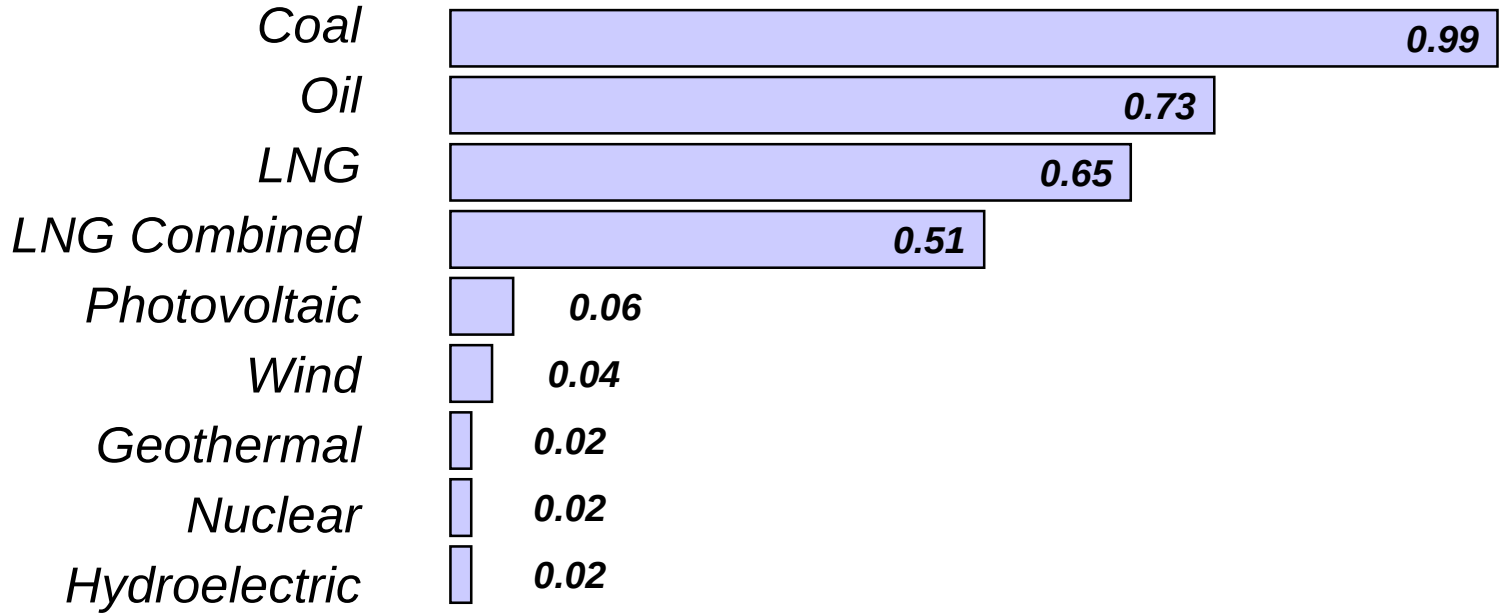
Energy Production



Source: EIA

Electricity Production

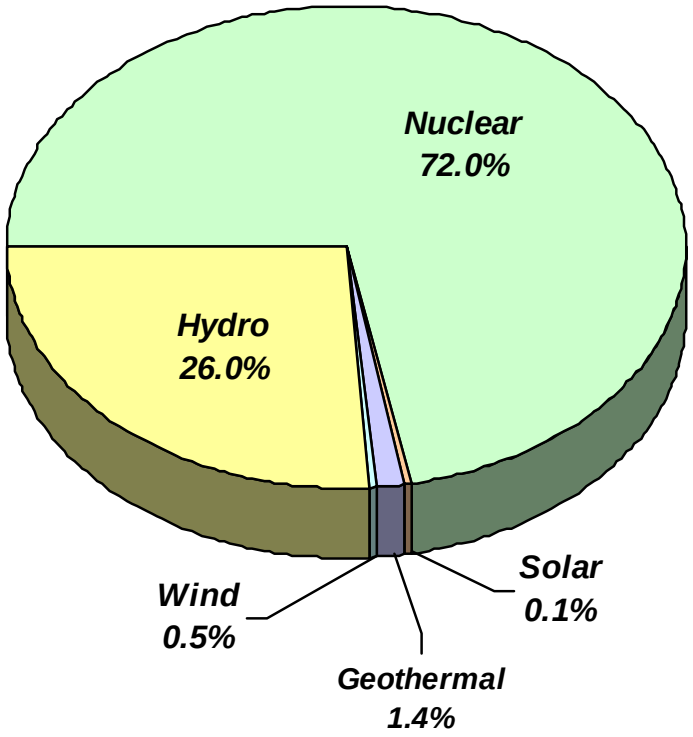
Comparison of CO_2 Emissions Intensity by Electrical Generating Fuel in Japan* (kg CO_2/kWhr)



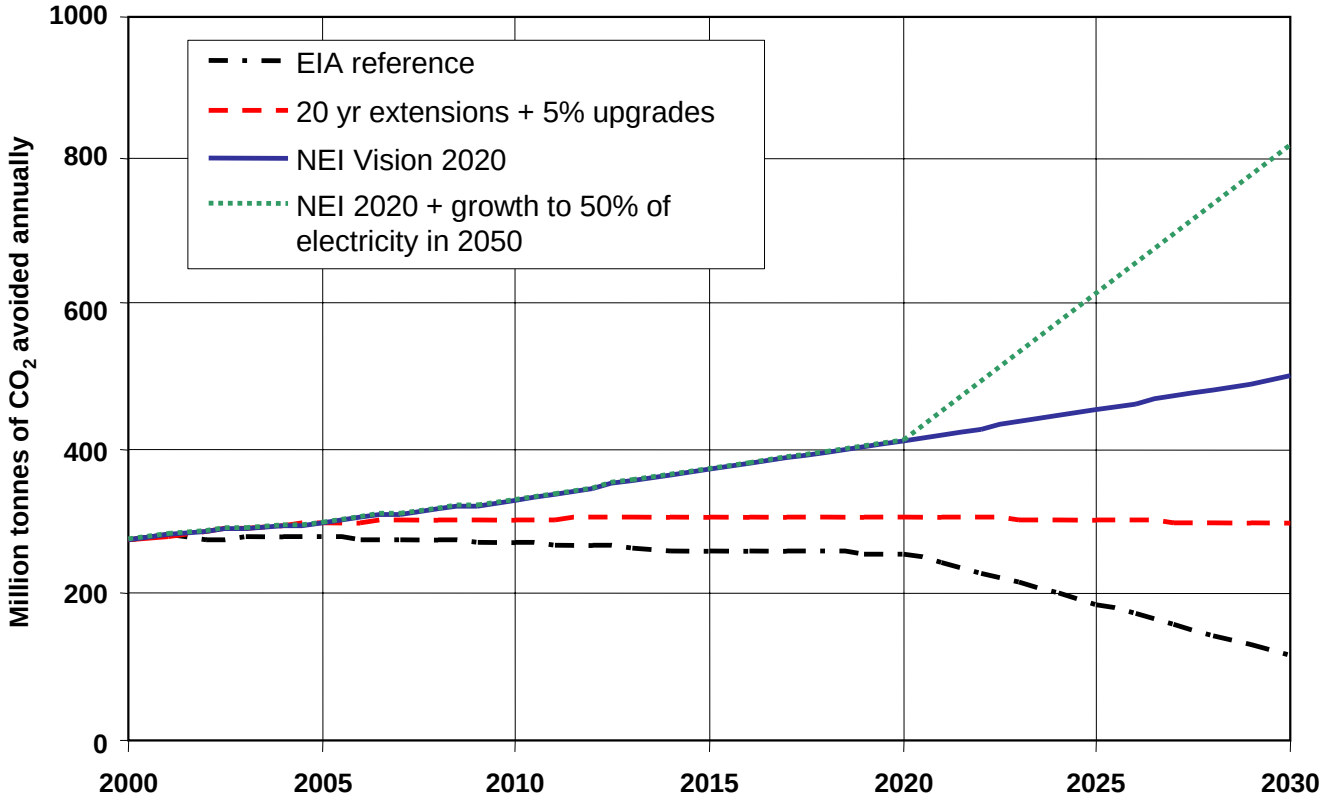
*** Total CO_2 emissions from mining, fuel transportation and refining, plant construction, operations, and maintenance. From report of the Central Research Institute of Electric Power Industry, Life Cycle Analysis of Power Generation System (March 1995)**

Nuclear Power is Helping Today

- ***Cleaner air***
  - *Emission-free generating sources supply almost 30 percent of America's electricity*
  - *Nuclear energy provides the greatest share of clean energy – almost three quarters*



Net Effect of Nuclear Power on U.S. CO_2 Emissions (million tonnes CO_2 emissions avoided)

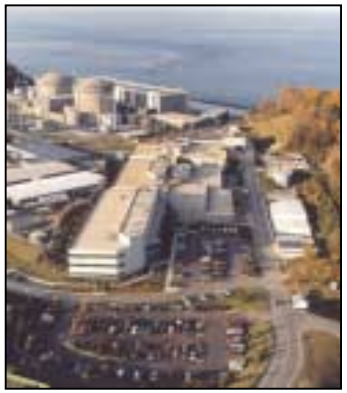


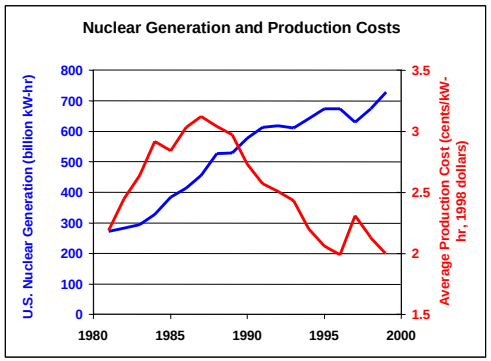
Ecosystem Impact Comparison (for 1000 MWe)

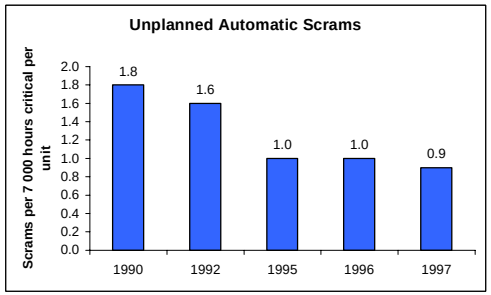
Method	Requirement	Land Area (square miles)
Photovoltaic	100 km^2 @ 10% efficiency	40
Wind	3000 wind turbines	40
Biogas	60,000,000 pigs or 800,000,000 chickens	
Bioalcohol	6,200 km^2 of sugar beets	2,400
	7,400 km^2 of potatoes	2,800
	16,100 km^2 of corn	6,200
	272,000 km^2 of wheat	104,000
Bio-oil	24,000 km^2 of rapseed	9,000
Biomass	30,000 km^2 of wood	12,000
Nuclear	< 1 km^2	1/3

The Nuclear "Paradigm" Has Changed

- *Industry has become economically competitive*
- *Substantial improvement in safety performance*
- *Growing public acceptance*
- *"Zero" emissions technology*
- *Energy security and environmental quality suggest nuclear energy for future growth*



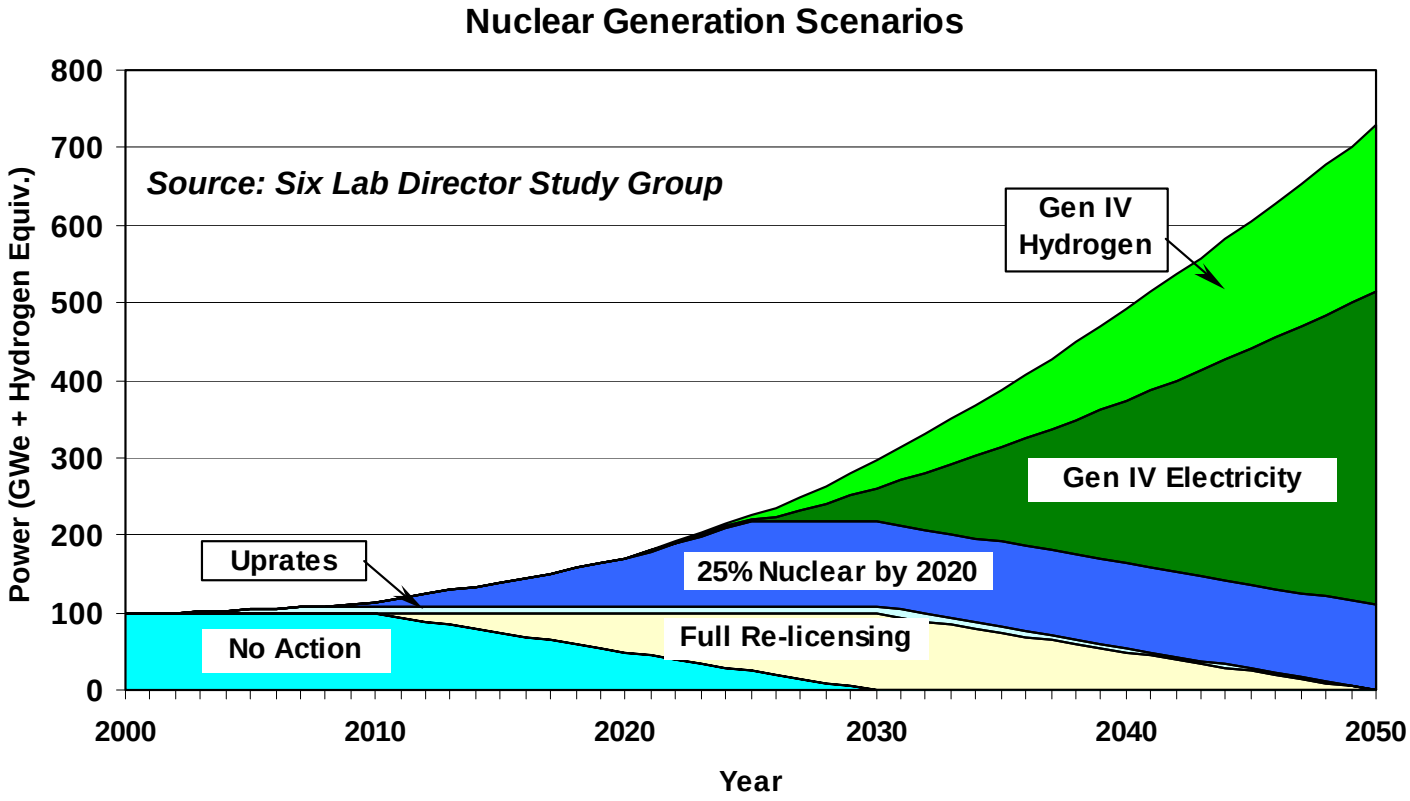




Why Nuclear energy?… it is an energy option we cannot ignore

- ***Oil***
  - *U.S. imports 51% of its oil supply*
  - *Vulnerable to supply disruptions and price fluctuations*
- ***Natural gas***
  - *Today's fuel of choice*
  - *Future price stability?*
- ***Coal***
  - *Plentiful but polluting*
- ***Renewables***
  - *Capacity to meet demand?*
  - *Still expensive*
- ***Nuclear***
  - *Proven technology*
  - *Issues remain*

Goals for the U.S. Nuclear Energy Supply



By 2050:

- ***Half of U.S. electricity production could be nuclear***
- ***One-quarter of U.S. transportation could by nuclear hydrogen***

Challenges to the Long-Term Viability of Nuclear Energy

Economics

- *Reduced costs (especially capital costs)*
- *Reduced financial risk (especially licensing/construction time)*

Safety and Reliability

- *Operations safety*
- *Protection from core damage (reduced likelihood and severity)*
- *Eliminate offsite radioactive release potential*

Sustainability

- *Efficient fuel utilization*
- *Waste minimization/management*
- *Nonproliferation*

The Generations of Nuclear Energy

Generation I

Early Prototype Reactors

- Shippingport
- Dresden, Fermi I
- Magnox

Generation II

Commercial Power Reactors

- LWR-PWR, BWR
- CANDU
- VVER/RBMK

Generation III

Advanced LWRs

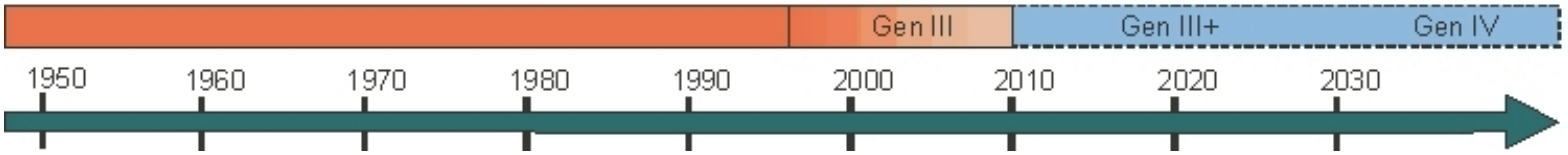
- ABWR
- System 80+

Generation III +

Evolutionary Designs Offering Improved Economics for Near-Term Deployment

Generation IV

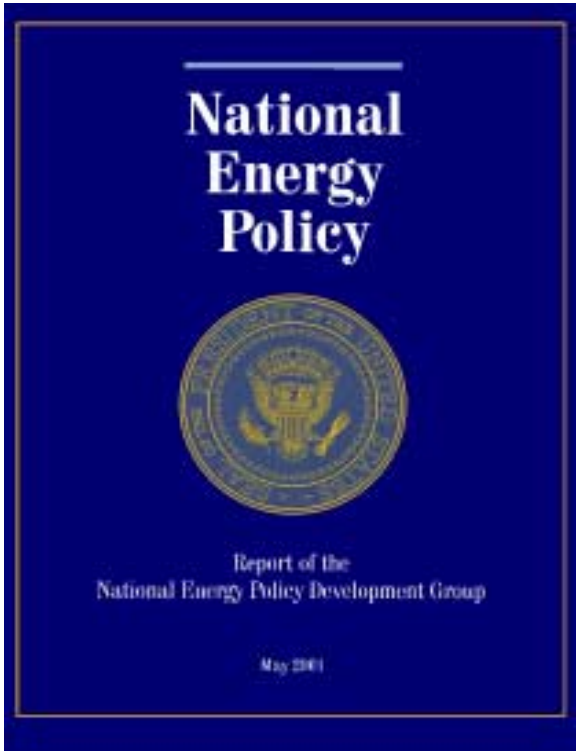
- Highly Economical
- Enhanced Safety
- Minimal Waste
- Proliferation Resistant



Generation IV Definition

Generation IV is the next generation of nuclear energy systems that can be licensed, constructed, and operated in a manner that will provide a competitively priced and reliable supply of energy to the country where such systems are deployed, while addressing nuclear safety, waste, proliferation and public perception concerns.

The National Energy Policy Endorses Nuclear Energy as a Major Component of Future U.S. Energy Supplies



Existing Nuclear Plants

- *Expedited NRC licensing of advanced reactors*
- *Update and relicense nuclear plants*
- *Nuclear energy's role in improved air quality*
- *Geologic repository for nuclear waste*
- *Price-Anderson Act renewal*

New Nuclear Plants

- *Advanced fuel cycle/pyroprocessing*
- *Next-generation advanced reactors*

Reprocessing

- *International collaboration*
- *Cleaner, more efficient, less waste, more proliferation-resistant*

US DOE Nuclear Power 2010 and Generation IV Programs are Addressing Near-Term Regulatory and Long-Term Viability Issues

NP-2010 Program

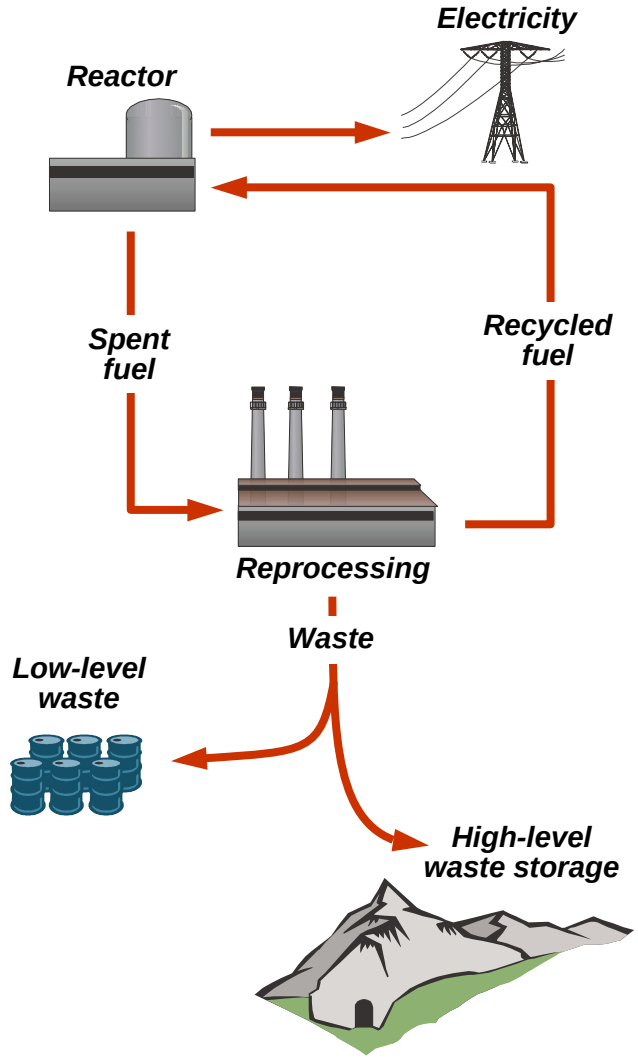
- *Eliminate regulatory uncertainties/demonstrate 10CFR52 Process*
- *Complete design and engineering*
- *Construct and deploy one light-water, and one gas-cooled reactor by 2010*

Generation IV Nuclear Energy Systems Program

- *Generation IV International Forum*
- *Concept screening and Technology Roadmap*
- *Broad spectrum of advanced system concepts*
  - ***High-temperature, gas-cooled reactor***
  - ***Liquid-metal-cooled reactors and recycle***
  - ***Supercritical-water-cooled reactors***

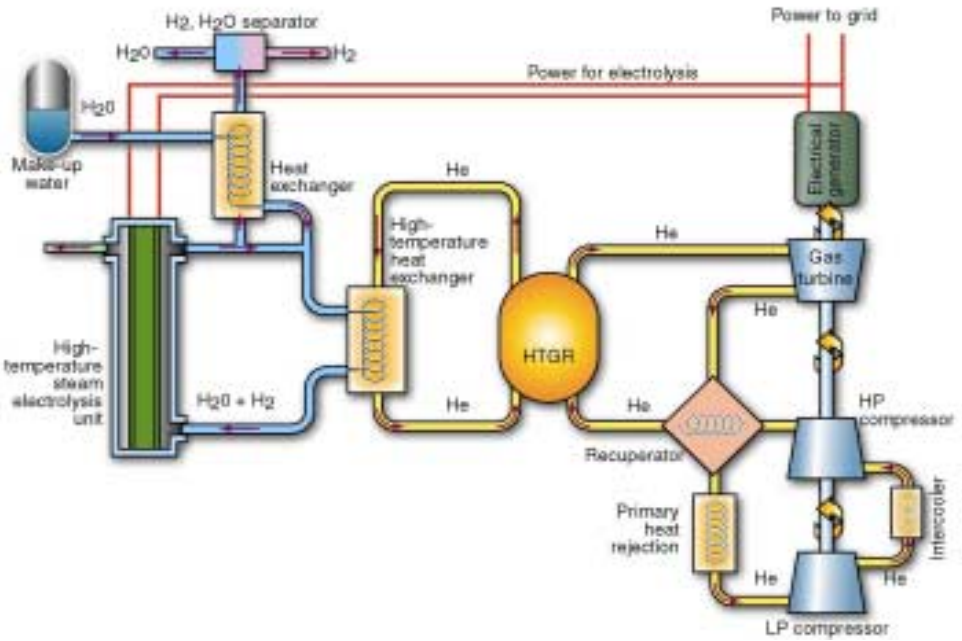
The Sustainable Fuel Cycle of the Future

- *Current U.S. "once-through" fuel cycle requires spent-fuel storage and management for thousands of years*
- *Lack of social/political acceptability of long-term waste storage may require a reexamination of U.S. waste management strategy*
- *Recycling of spent fuel reduces volume (96%) and lifetime (few hundred years) of disposable waste*
- *Advanced "fast" reactors can recycle multiple times*
  - *Burns plutonium and other long-lived materials*
  - *Extends fuel supplies 100X*
- *New recycle technology reduces nuclear materials proliferation-concern*



High Temperature Nuclear Reactors May Contribute to Hydrogen Production

- *Energy security and environmental quality motivate hydrogen as a alternative to oil as a transportation fuel*
- *Hydrogen demand is already large and growing rapidly*
  - ***Heavy-oil refining***
  - ***Consumes 5% of natural gas for hydrogen production***
- *Bridge to the hydrogen economy*
  - ***Hydrogen fuel cells***
  - ***Zero-emissions transportation fuel***
  - ***Distributed energy opportunity***
  - ***Large-scale, zero emissions hydrogen production is an enabling technology***
- *Water is the preferred hydrogen "fuel"*
  - ***Electrolysis using off-peak power***
  - ***High-temperature electrolysis***
  - ***High-temperature thermochemical water splitting***



Summary and Implications for the Future

- *Economics, operating performance and safety of U.S. nuclear power are excellent*
- *Nuclear power is already a substantial contributor to reducing CO_2 emissions*
- *Nuclear power can grow in the future if it can respond to the following challenges:*
  - *remain economically competitive*
  - *retain public confidence in safety*
  - *manage nuclear wastes and spent fuel*

- *Nuclear power's impact on U.S. energy security and CO_2 emissions reduction can increase substantially with increased electricity production and new missions (hydrogen production for transportation fuel)*